1986 Annual report

Project 86-KA13 Tree and Crop Research
Bud Failure and Nonproductivity Disorders

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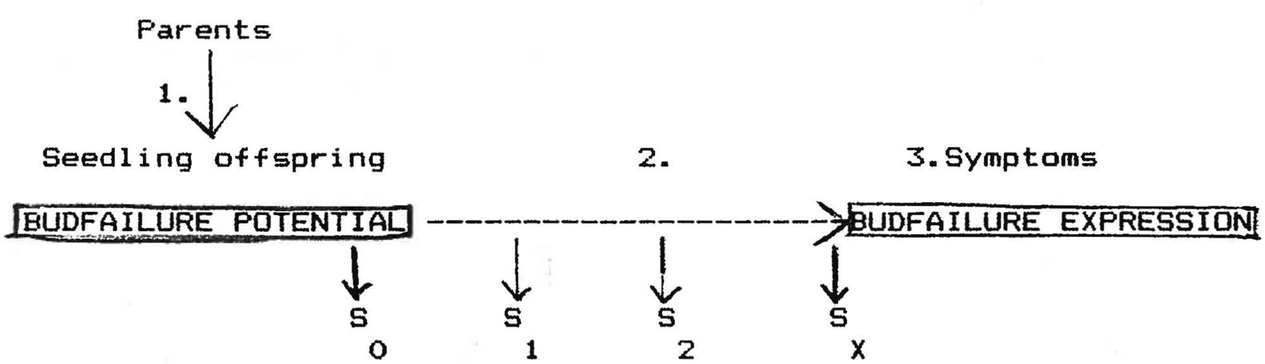
Objectives: (1) Survey the occurrence of bud-failure in Carmel and other new varieties in order to verify the bud failure (BF) variety model and to assess the future potential for failure in these varieties. (2) Apply vegetative and seedling progeny tests to characterize BF resistance in additional varieties and variety sources. (3) Establish a system of shoot tip culture for the purpose of maintaining and multiplying stock plants of low BF-potential sources either for commercial distribution programs or as a research tool. (4) Complete the analysis of possible isozyme genetic linkage to BF in F_1 (first generation) and F_2 (second generation) almond-peach seedling populations. (5) Locate a plot in a cooler coastal area where source material with low BF potential could be maintained. (6) Complete a publication in lay terms summarizing present knowledge on BF.

Interpretive summary:

An updated summary on bud-failure which applies knowledge obtained through this project was prepared and distributed at the annual Research Conference.

The concept underlying research on noninfectious bud-failure (BF) can be summarized in the following diagram:



in which a genetic factor (BF-POTENTIAL) is inherited (1) that predisposes the seedling offspring to produce budfailure symptoms

(BF EXPRESSION). The initial BF-POTENTIAL is converted (2) over a period of time to a level of higher BF-potential at which specific symptoms, i.e., "bud-failure", "roughbark" and "crazytop" (3) can occur. A bud used for vegetative propagation perpetuates the BF-potential of that part of the shoot on which it grew and gives rise to sources (S) with characteristic BF-potential.

BF-potential is defined as the "probability to develop BF-symptoms" and is measured as the time from propagation to the age at which symptoms appear in progeny plants.

I.

A BF model was described in 1985 that defines the process that occurs in step 2 of the diagram. The mathematical expression can be used to characterize the variability in BF-potential within a variety, to make predictions about future development from specific sources and to provide the rationale for selection of low BF-potential sources. BF-potential is defined mathematically in terms of a rate factor (the age required for BF symptoms to appear) and a scale factor (the variability in BF potential). Rate is directly proportional to the accumulated degree days 80 deg.F or more.

In 1986, further progress was made in defining the process of BF development by finding that the greatest changes in BF-potential occur during growth in the nursery and in the first 6-7 years in the orchard. During these critical periods, the greatest amount of continuous vegetative growth is occurring and the structure of the tree is being established. After the structure is established, the numbers of new trees affected annually is related to seasons following years of very hot summers (i.e. greater accumulation of degree days over 80F) and/or when much vegetative shoot growth has occurred.

Further analysis of data from vegetative progeny tests identified kinds of sources as ORCHARD SOURCES, PROGENY ORCHARD SOURCES, SINGLE TREE SOURCES and SOURCE-CLONES. The most promising long range direction for source improvement was concluded to be the selection of source-clones with predetermined BF-potential combined with procedures to prevent or delay increases in BF-potential. Eight specific source-clones of Nonpareil have been selected that did not produce symptoms within at least 13 years of testing in a high summer temperature environment.

II

Laboratory work involved continued experiments to establish and grow source-clone material of Nonpareil with predetermined BF-potential in test tubes.

(a) Shoot tips from low and high BF-potential sources were established and multiplied. These grew well but those from the BF-affected sources tended to produce abnormalities and gradually died out.

(b). New callus cultures from high and low BF-potential sources also were established in summer 1985 and subcultured at monthly intervals. The callus from the high BF-potential sources have produced much greater masses of callus then have those from the low BF-potential sources indicating major physiological differences in their basic response to culture, repeating what has been shown earlier.

(c). Cell cultures from Lou Fentons earlier work has been maintained and some have been allowed to revert to callus. The behavior of this material has shown evidence that the cells from the low BF-potential sources shows conversion to high BF-potential and the material from high BF-potential sources has tended to deteriorate in growth rate or has reverted.

III

Further laboratory work in 1986 was done to measure seasonal changes in the physiology and performance of buds and leaves collected monthly and/or weekly from trees of non BF-affected (low BF-potential sources) and BF-affected (high BF-potential) in an effort to define the changes taking place with the initiation of symptoms (see step 3 in diagram). These studies are being carried out in collaboration with Dr. Durzan (Project 86-KB1) who is defining metabolic maps involving amino acids. Our measurements have included bud forcing in petri dish tests, bud necrosis, and some associated chemical testing including tetrazolium chloride (TTC) staining and proline levels. Within this information we expect to be able to correlate the time of symptom development, which has been occurring from September, to the internal changes that are being defined by Dr. Durzan. The study is not yet complete and will be reported as the study is completed.

IV

The mathematical model for BF development is being applied to data on the inheritance of BF in almond x almond and almond-peach populations but the statisical analysis is still incomplete. However, the preliminary information is that the model applies directly to the almond x almond studies. For instance, the calculated rate factor of particular populations where BF is beginning to appear in some individuals of the offspring population can be used as a measure of the BF-potential of the parent variety being used. Thus seedlings provide another progeny test (in addition to the vegetative progeny test) for measuring inherent BF-potential.

Data from seedling populations produced since 1978 (about 2500 individuals with 40 or 50 crosses) have contributed to this study. Also a compilation and tentative analysis for BF-potential is under way for the large numbers of germplasm accessations growing in the UCD orchards at the present time. In addition selections for potential commercial use has been made from recent seedling progeny resulting from low BF-potential parental germplasm. A discussion of this item is being included in project 86L13 (Field Evaluation of Almond Varieties).

As reported previously, inheritance with almond-peach F1 and F2 population have shown different results from that of almond-almond crosses. A process of segregation of a highly potent BF-potential phenotype appears to be involved and we have been trying to associate the BF trait with other specific characters to which they might be linked. This result would indicate a chromosomal location for the BF-potential factor. Theoretically one could also base selection for low BF-potential (or BF-absence) on other readily identifiable traits. For example, some preliminary analysis had suggested a possible linkage of an isozyme with seedling losses due to BF. A study of F1 populations carried out in collaboration of Drs. Arulsekar and Parfitt (Davis Germplasm Repository) did not confirm the hypothesis but the study might have to be done with th F2 population. A trait that has been associated with BF-potentiality, however, is time of blooming (or leafing) and their is a strong indication that selection for later blooming individuals may also result in lower (not absence) BF-potential.

A population of about 2500 individuals was planted in 1981 derived from growing seeds collected from F1 individuals derived from crossing a genetic dwarf peach and Nonpareil, with and without BF, and about six almond varieties some of which have shown to have low BF potential in other tests. We have been identifying not only BF individuals in their progeny but also other traits of peach and almond growth habit, yield potential, blooming time, tree size, and nut characteristics. About 25% segregated the dwarf peach character and provided an opportunity to compare the performance of this kind of dwarfed material with the normal sized individuals with the same genetic background. In collaboration with Dr. Steve Weinbaum, a number of highly SELF-FERTILE individuals have been identified, some of which have other useful traits of value in breeding.

Work in progress includes (a) attempts to correlate individual almond and peach traits with both BF-EXPRESSION and SELF-FERTILITY, (b) analysis of yield potential of growth habit including the genetic dwarfs and (c) selection of parental and germplasm material with low (or no) BF-potential, high yield potential, self-fertility and good almond nut characteristics. Our conclusion is that there is highly promising genetic material in these populations that should now be exploited in specific breeding programs.

In this material the genetic dwarfs segregated BF phenotypes as did the normal sized trees. Furthermore the genetic dwarfed plants produced a wide range of trees sizes from very small to medium and considerable variation in tree structure. In general all had extremely dense flowering which began mostly in the third season similar to that of the normal sized trees. However, in this material the ability to set fruit tended to be poor as compared to the comparable trees that were not dwarfed. There was a lot of variation and some individuals did set reasonably well but were then not very capable of return bloom. The reason for this generally poor performance is not clear and it is uncertain (a). how much it is due to environmental effects, e.g., disease (due to the intense foliage density), shading, nutrition, lack of cross-pollination or other, (b). how much due to genetic differences, (c) and how much due to genetic-environmental interactions. Performance of these and similar materials of Dr. Hansche in 1987 should provide important information as to their potentiality.

V.

More detailed descriptions of each of the experimental areas will be provided from time to time as they are completed.

Bibliography

Kester, Dale E. and Warren C. Micke. 1986. NONINFECTIOUS BUD-FAILURE IN ALMOND - AN UPDATE. University of California, Davis. Xeroxed report.